2 1992

LAW ENGINEERING

GEOTECHNICAL, ENVIRONMENTAL
& CONSTRUCTION MATERIALS
CONSULTANTS

March 31, 1992

County of Loudoun
Department of Natural Resources
750 Miller Drive, S.E., Suite 200
Leesburg, Virginia 22075-8919

ATTENTION: Mr. Robert F. Montgomery
Deputy Director

SUBJECT: Remediation of Monitoring Wells
Loudoun County Landfill
Loudoun County, Virginia
Law Engineering Project No. W9-7471

Gentlemen:

Enclosed are the final well logs for MW-11, 12, 13, and 14. Note the well logs reflect the correct symbols for the well installation. Remedial measures were performed at the top of these wells by both Groundwater Systems, Inc. and Law Engineering. The remediation consisted of removal of the concrete seal at the ground surface and excavation of the near surface soils surrounding the protective casing and standpipe to the top of competent grout. The anular space was then backfilled with concrete to the ground surface.

Also enclosed is the well log for MW-11A which was redrilled.

We have received the results of the grout samples tested by Artech Corp. As agreed at our meeting, we have also engaged an analytical laboratory and tested samples of the bentonite-cement grout used in the well installation. A copy of the test report is attached. *(There is no connection between Law & Company and Law Engineering other than similar names).*

The results of the testing by both analytical laboratories appear to differ significantly in indentification of the grout. Artech states that the "white crystalline material" is calcium aluminate (a type of slag). This type of compound would be common in the production of cement and, in our opinion, is in fact a reflection of the cement utilized in the grout mix. To further substantiate this I contacted the producer of the bentonite used on the project (American Colloid Company). There is no "slag" in their product Volclay Super Gel-X which was used at the site.

4465 BROOKFIELD CORPORATE DRIVE
CHANTILLY, VA 22021
(703) 968-4700
TELEFAX 703-968-4778

We have received your letter of March 26, 1992 and believe that our remediation activities and enclosures with this correspondance complete our obligation to the County. We do not intend to geophysically log any of the wells. This was not part of the scope of work included in our letters to the County on January 20, 1992 or December 23, 1991. Our investigative work on MW-13 and analytical testing of the grout mix has not indicated that our procedures or materials were outside of our contract specifications with the County. Therefore, in our opinion, no geophysical testing is warranted.

We would be glad to discuss our procedures and test results with the Department of Waste Management if that would assist the County. However, if the County should choose to replace wells MW-12, 13, and 14, they do so at their own cost. Law Engineering is willing to compensate the County for the concrete cap reconstruction at wells MW-12 and MW-14. We beleive this work was incidental to the well construction and has not compromised that functioning of the wells. As for the analytical testing performed by Artech Corp., we cannot substantiate that their testing and interpretation of the results was correct and therefore, do not feel any obligation to remburse them for their work.

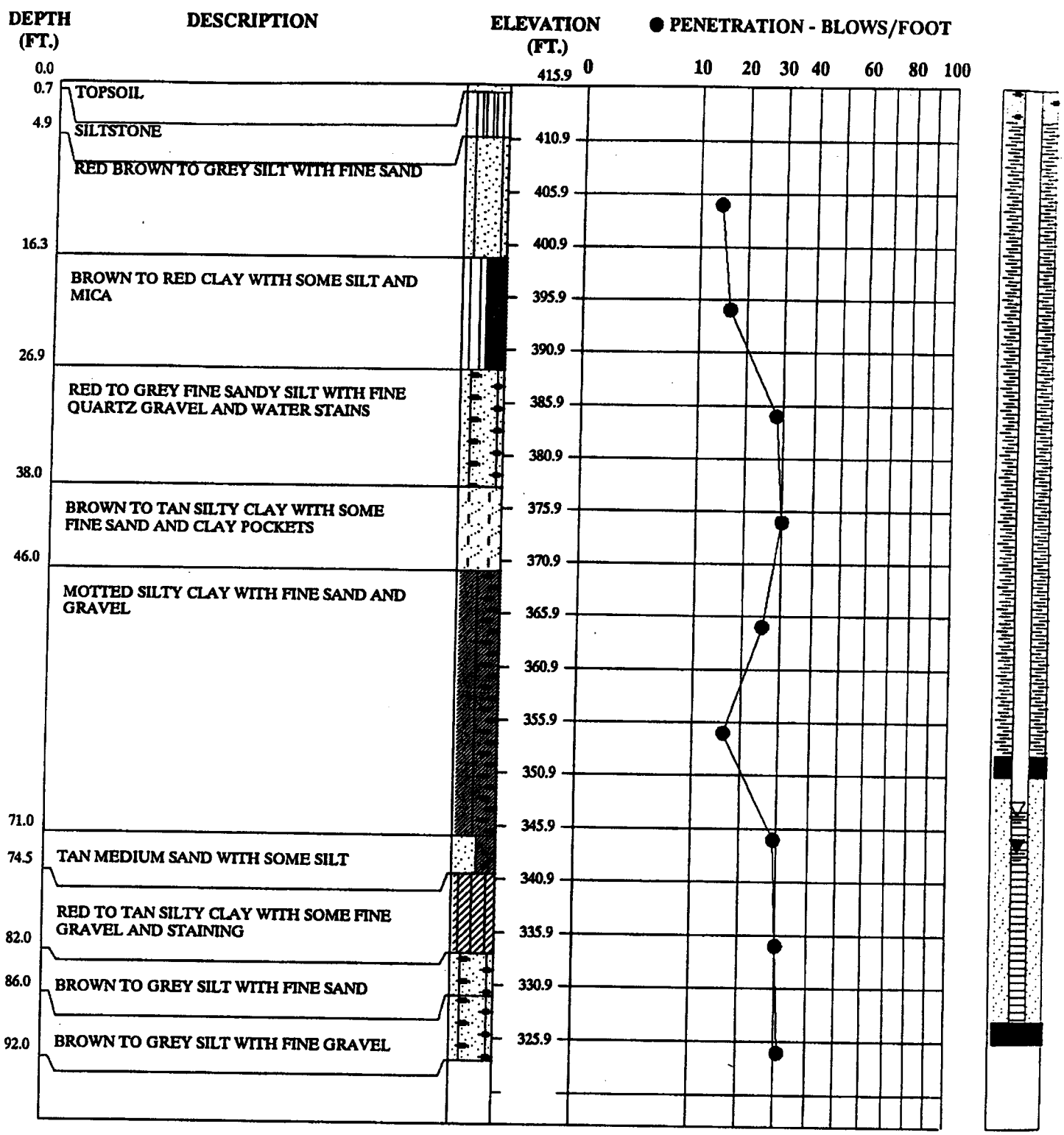
In summary, we regret the fact that the County has doubts about the construction of the wells. The work Law Engineering was allowed to conduct subsequent to the initial installation has shown to our satisfaction that the well construction was performed in accordance with the contract specifications and should be acceptable to DWM.

If we can be of any further assistance, please contact the writers.

Very truly yours,
LAW ENGINEERING, INC.

Paul G. Swanson, P.E.
Chief Engineer

for Douglas R. Dunko
Drilling Services Manager



REMARKS:

4-inch Type II monitoring well installed with well point at 88 feet below top of ground (TOG). Bottom 20 feet of well pipe consists of 0.01-inch stain- less steel slotted screen. Bladder pump intake is located at 83 feet TOG.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	MW-11
DATE DRILLED	August 9, 1989
PROJECT NUMBER	W9-7471
PROJECT	Loudoun County Landfill
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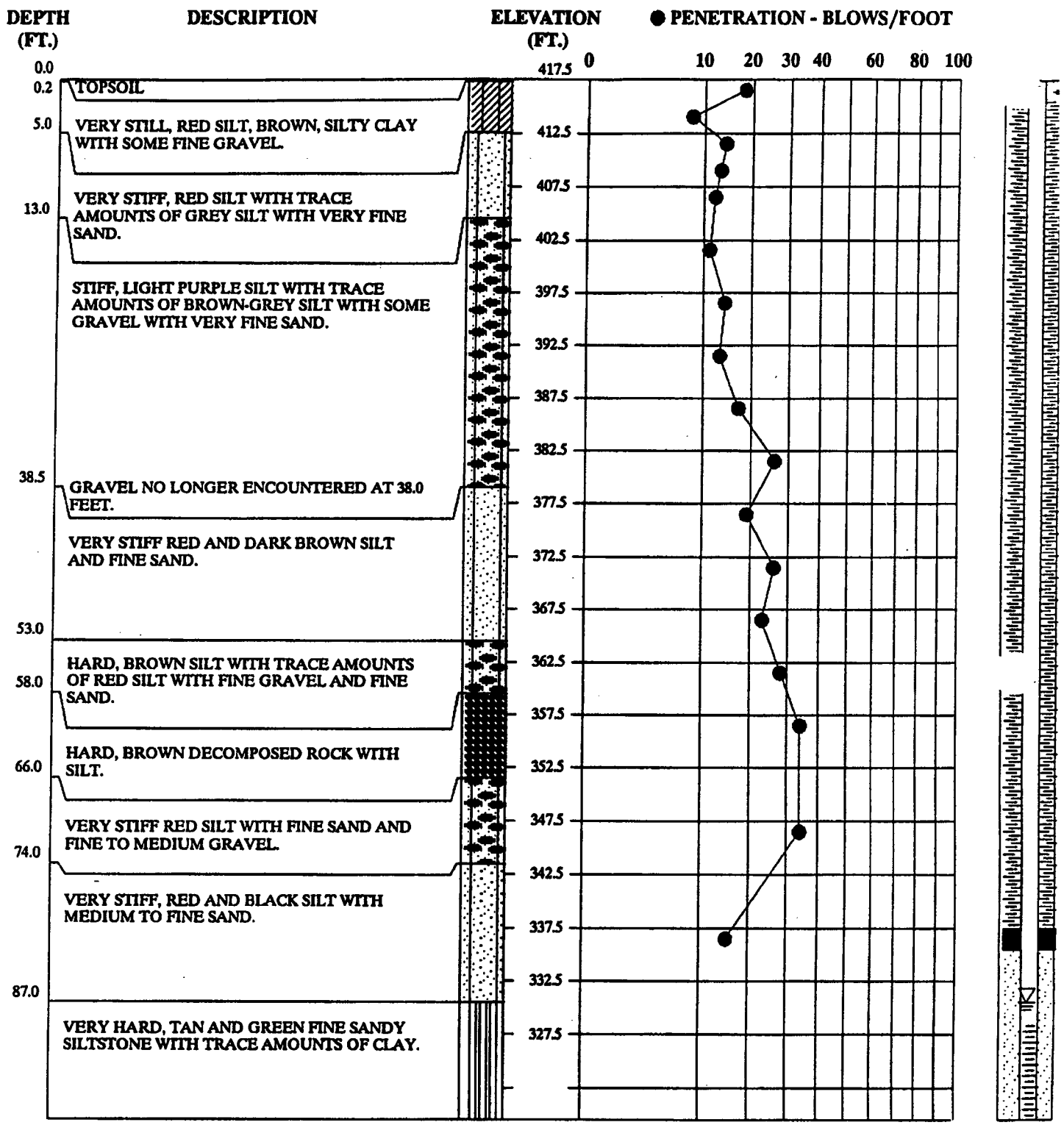
LAW ENGINEERING



REMARKS:

Groundwater Systems, Inc. air drilled from 87 feet to 112 feet. Well screen set from 89 feet to 109 feet.

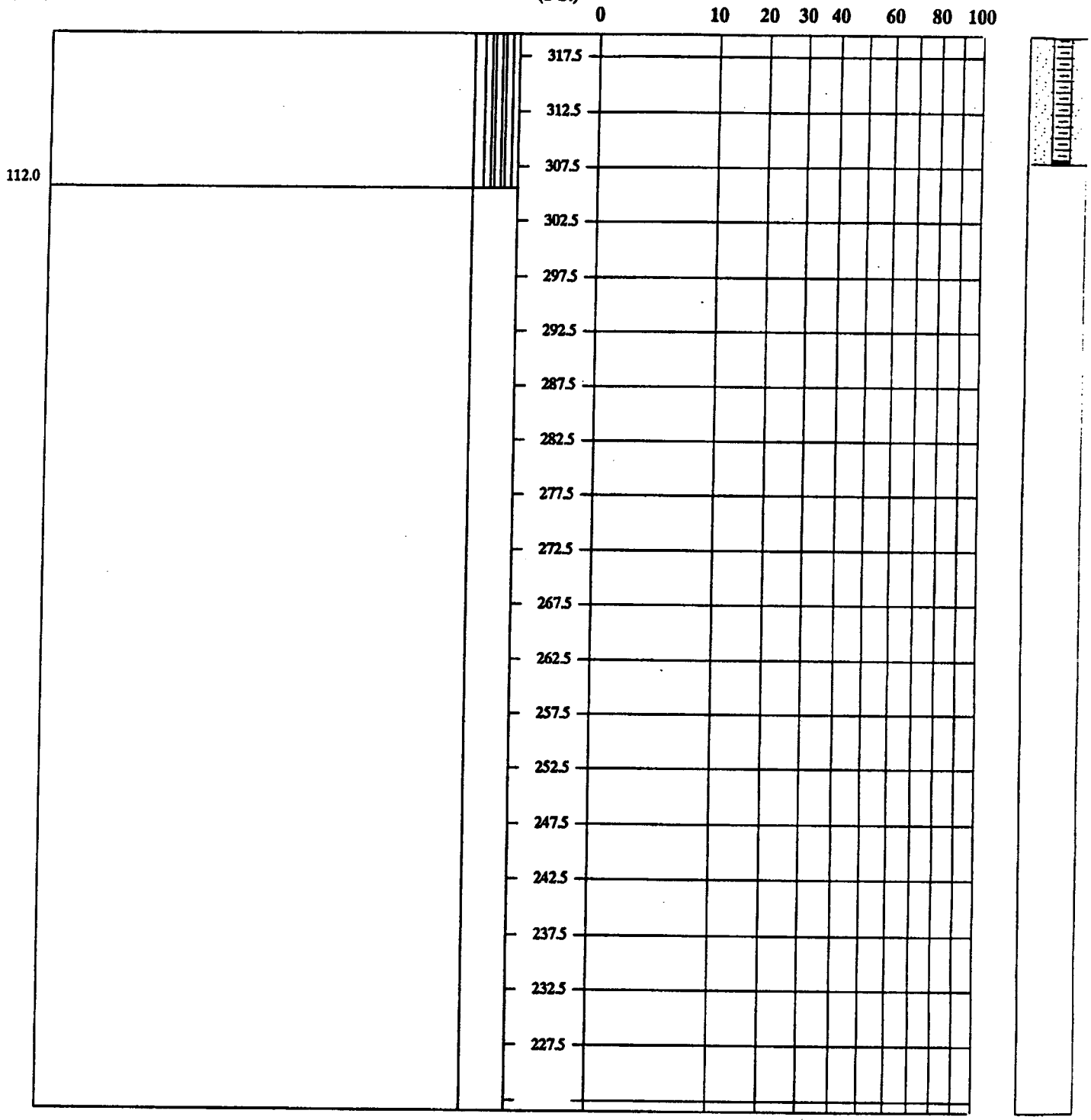
SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	MW-11A
DATE DRILLED	March 6, 1992
PROJECT NUMBER	W9-7471
PROJECT	Loudoun County Landfill
PAGE 1 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)	● PENETRATION - BLOWS/FOOT



REMARKS:

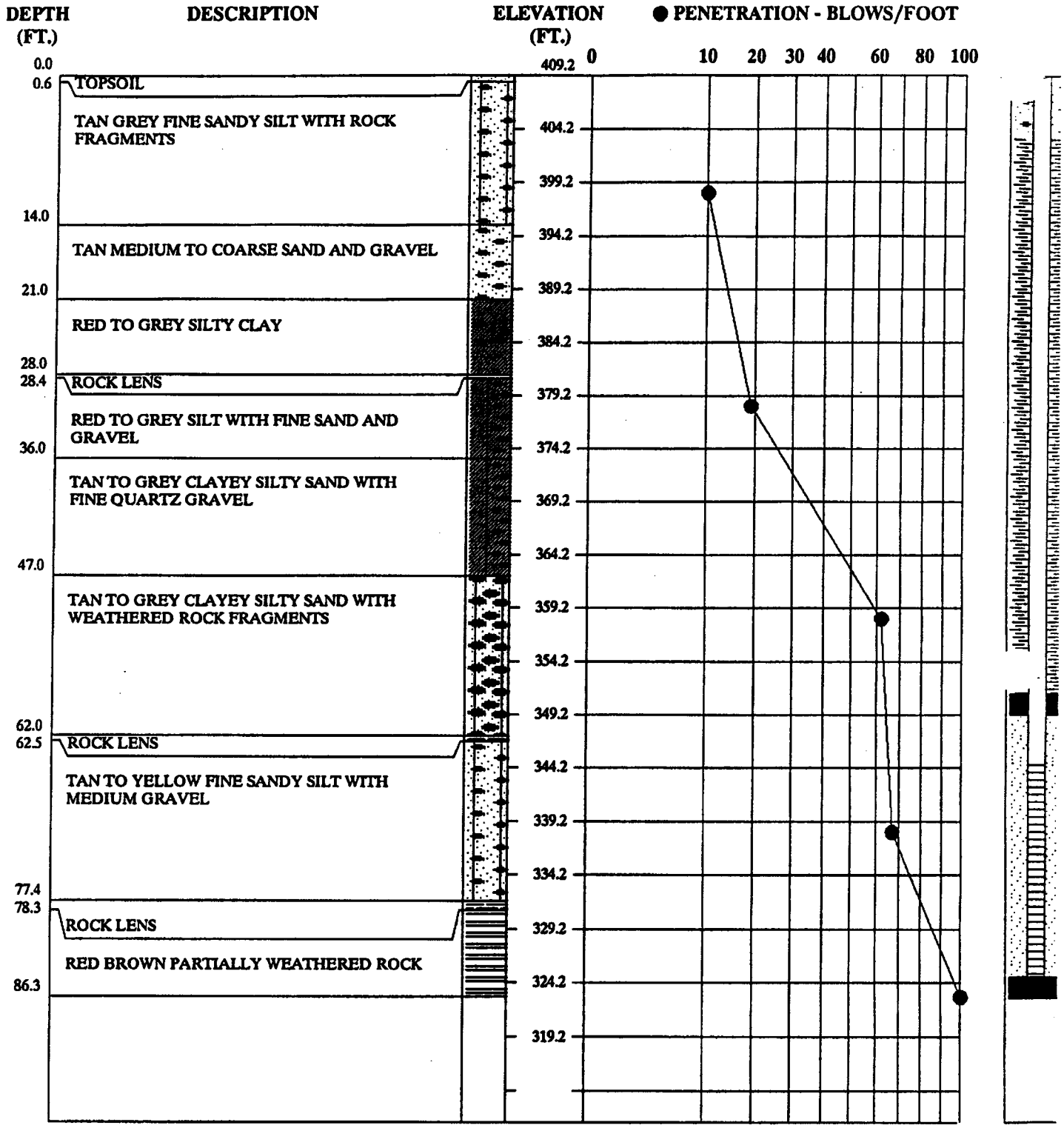
Groundwater Systems, Inc. air drilled from 87 feet to 112 feet. Well screen set from 89 feet to 109 feet.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	MW-11A
DATE DRILLED	March 6, 1992
PROJECT NUMBER	W9-7471
PROJECT	Loudoun County Landfill
PAGE 2 OF 2	

LAW ENGINEERING



REMARKS:

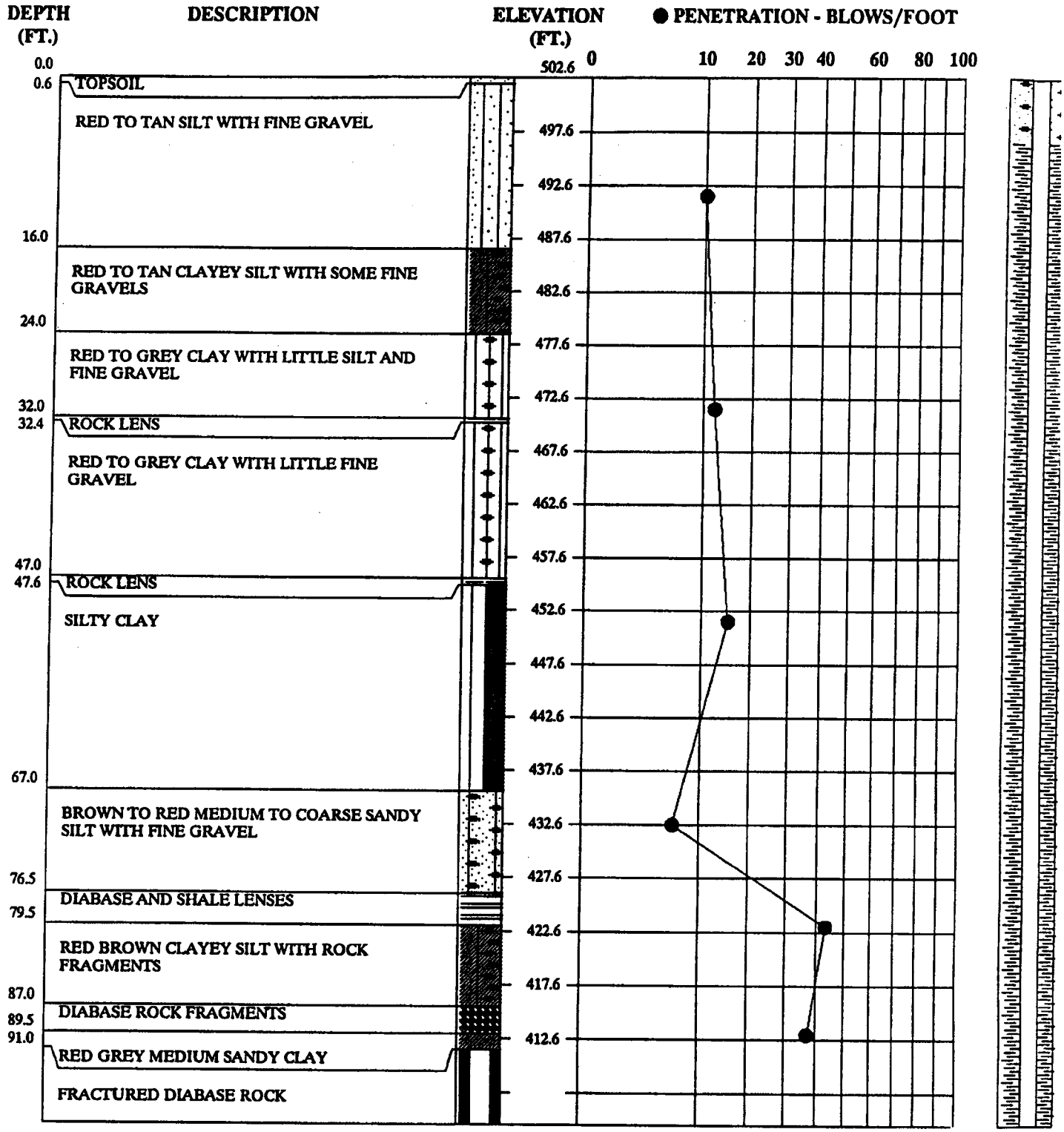
4-inch Type II monitoring well installed with well point at 84.5 ft below top of ground (TOG). Bottom 20 ft of well pipe consists of .010-inch stainless steel slotted screen. Bladder pump intake is located at 81.5 ft TOG

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	MW-12
DATE DRILLED	August 17, 1989
PROJECT NUMBER	W9-7471
PROJECT	Loudoun County Landfill
PAGE 1 OF 1	

LAW ENGINEERING



REMARKS:

4-inch Type II monitoring well installed with well point at 125 ft. below top of ground (TOG). Bottom 20 ft. of well pipe consists of .010-inch stainless steel slotted screen. Bladder pump intake is located at 122 ft. TOG.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

TEST BORING RECORD

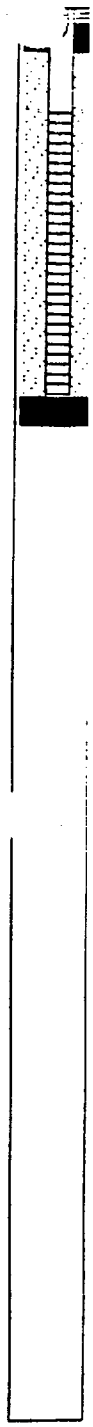
BORING NUMBER	MW-13
DATE DRILLED	August 21, 1989
PROJECT NUMBER	W9-7471
PROJECT	Loudoun County Landfill
PAGE 1 OF 2	

LAW ENGINEERING

DEPTH (FT.)	DESCRIPTION	ELEVATION (FT.)
	AIR HAMMER DRILL RIG ADVANCE BORING TO LOCATE WATER BEARING ZONE	402.6
	FRACTURED DIABASE ROCK	397.6
		392.6
		387.6
		382.6
		377.6
		372.6
		367.6
		362.6
		357.6
		352.6
		347.6
		342.6
165.0		337.6
		332.6
		327.6
		322.6
		317.6
		312.6

● PENETRATION - BLOWS/FOOT

0 10 20 30 40 60 80 100



REMARKS:

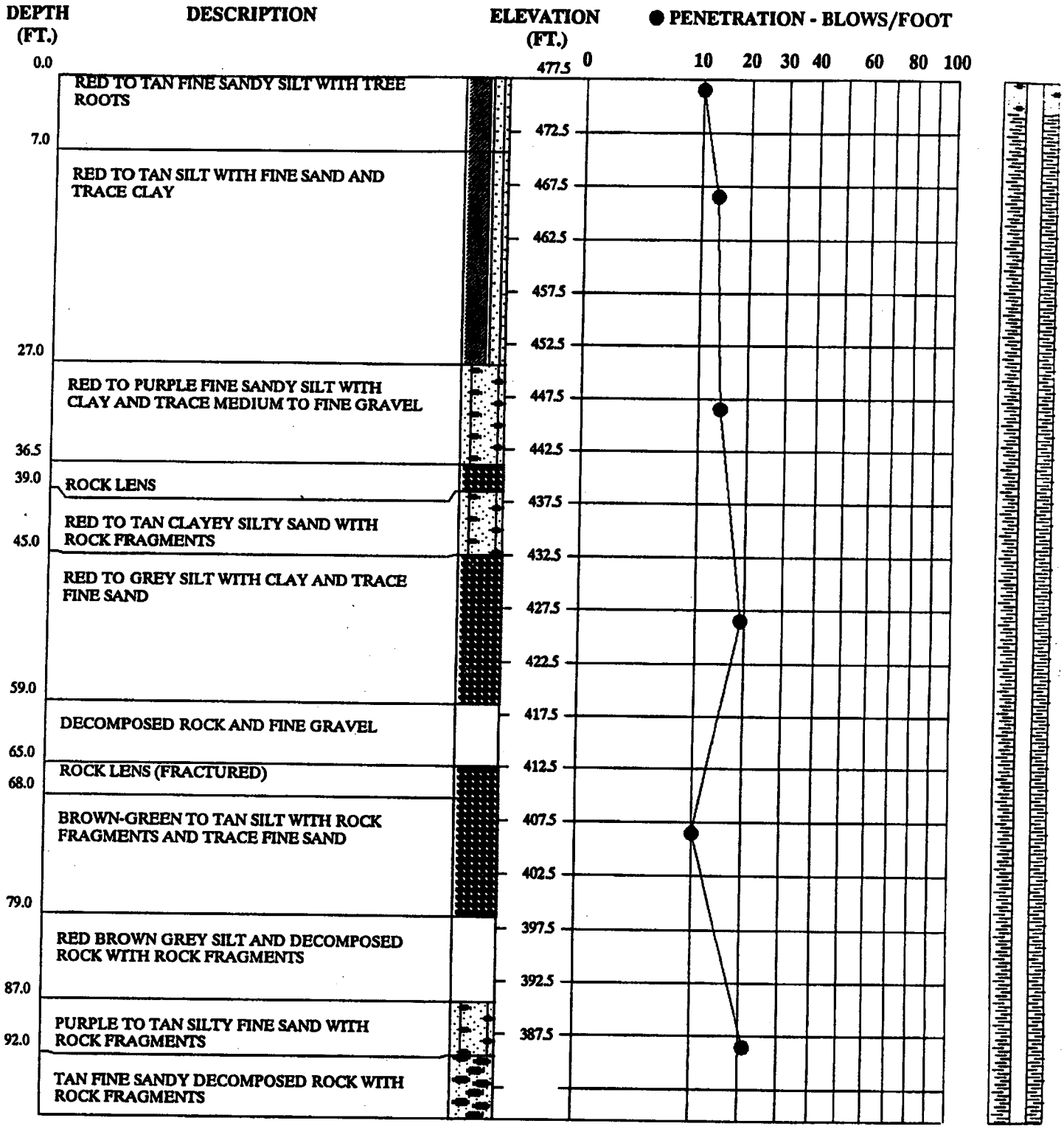
4-inch Type II monitoring well installed with well point at 125 ft. below top of ground (TOG). Bottom 20 ft. of well pipe consists of .010-inch stainless steel slotted screen. Bladder pump intake is located at 122 ft. TOG.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	MW-13
DATE DRILLED	August 21, 1989
PROJECT NUMBER	W9-7471
PROJECT	Loudoun County Landfill
PAGE 2 OF 2	

LAW ENGINEERING



REMARKS:

4-inch Type II monitoring well installed with well point at 138 ft. below top of ground (TOG). Bottom 20 ft. of well pipe consists of .010-inch stainless steel slotted screen. Bladder pump intake is located at 135 ft. TOG.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	MW-14
DATE DRILLED	September 1, 1989
PROJECT NUMBER	W9-7471
PROJECT	Loudoun County Landfill
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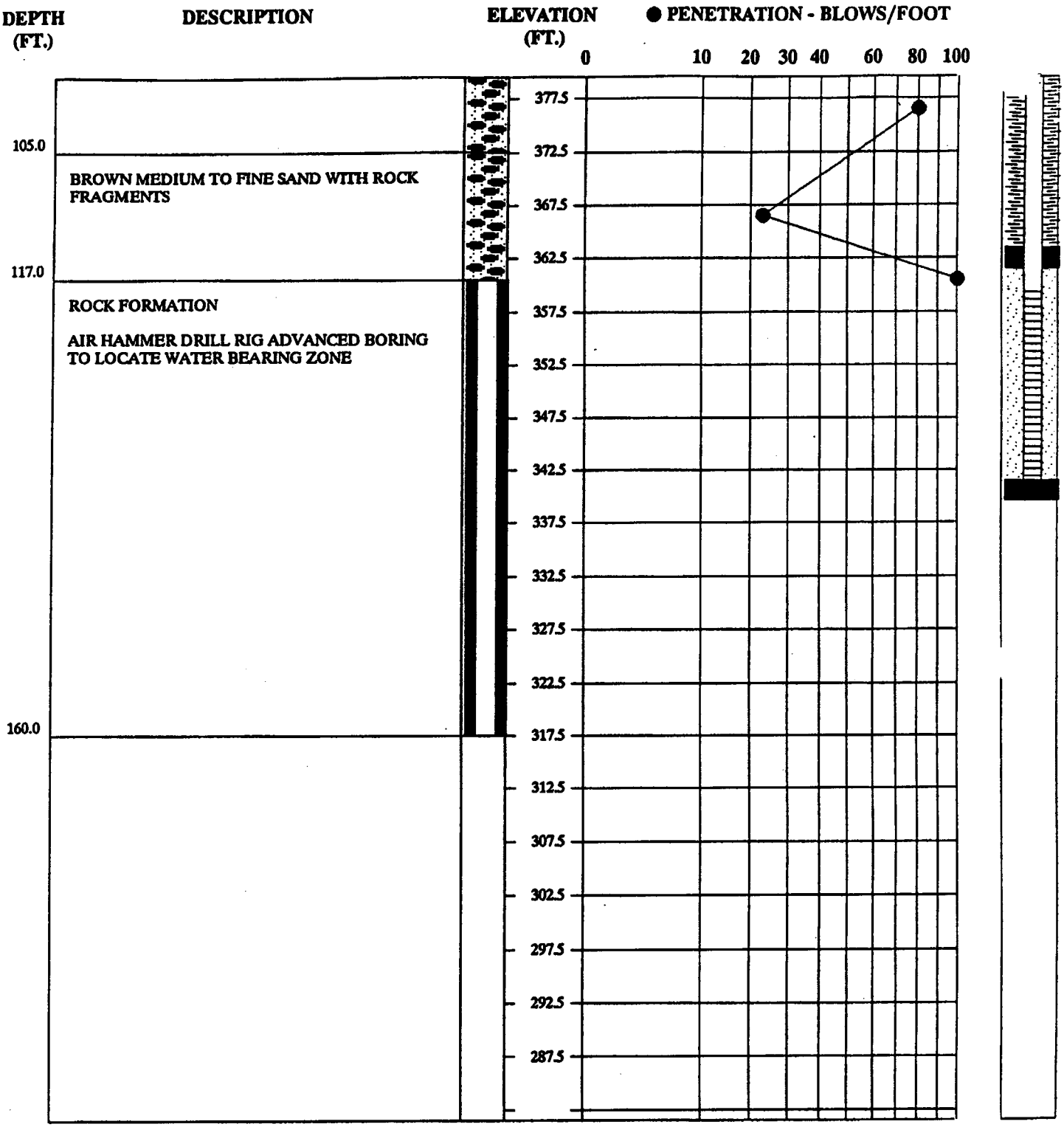
LAW ENGINEERING



REMARKS:

4-inch Type II monitoring well installed with well point at 138 ft. below top of ground (TOG). Bottom 20 ft. of well pipe consists of .010-inch stainless steel slotted screen. Bladder pump intake is located at 135 ft. TOG.

SEE KEY SHEET FOR EXPLANATION OF SYMBOLS AND ABBREVATIONS USED ABOVE

TEST BORING RECORD

BORING NUMBER	MW-14
DATE DRILLED	September 1, 1989
PROJECT NUMBER	W9-7471
PROJECT	Loudoun County Landfill
PAGE 2 OF 2	

LAW ENGINEERING

LAW & COMPANY
CONSULTING AND ANALYTICAL CHEMISTS
1763 MONTREAL CIRCLE
TUCKER, GEORGIA 30084
(404) 934-8200

Chemical Report

2/7/92

Number 884530-1

Received: 1/23

33340
Mr. John Smith
Law Engineering
4465 Brookfield Corp., Drive
Chantilly, VA 22021

Description: Grout samples, #480-7479/a50-635

Sample Number	884530	884531
Identification	MW-12 2'	MW-13
Loss on ignition @ 800°C	27.35 %	49.32 %
Acid insoluble (aggregate)	5.61 %	19.24 %
Soluble Silica (SiO_2) (ASTM C1084) ...	10.97 %	8.44 %
Soluble Calcium (CaO) (ASTM C1084) ...	38.16 %	20.53 %
Soluble Alumina (Al_2O_3)	2.27 %	2.04 %
Total Alumina (Al_2O_3)	3.11 %	5.93 %

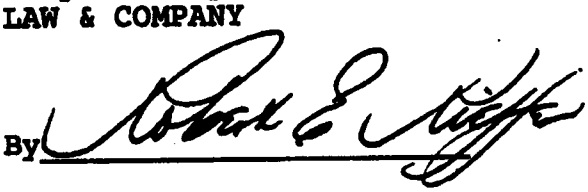
The above analysis indicates the following:

Loss on ignition (water of hydration + CO_2)	27.4 %	49.3 %
Aggregate	5.6 %	19.2 %
Cement (basis 63.5% CaO)		32.3 %
Excess Silica (as SiO_2)		1.7 %
Cement (basis 21.0% SiO_2)	52.2 %	
Excess Calciun (as CaO)	6.0 %	
Estimated Volclay (discussion below)..	3.8 %	16.5 %

An estimation of the amount of Volclay present has been attempted based on some assumptions. First it is assumed that the alumina content of the cement is approximately 3.9%. This value is a fairly typical value. The second assumption is that the chemical composition of the Volclay is $Al_2O_3 \cdot 4SiO_2 \cdot H_2O$. This is the general formula for Montmorillonite. These estimations probably represent a maximum amount present. If the alumina content of the cement used were higher (the maximum from ASTM specification is 6.0%), a lower value for the estimated Volclay would result. Also if the actual alumina content of the Volclay were different from that assumed, a different value would result. The soluble alumina found in the MW-12 sample closely approximates the estimated alumina from the cement content, based on the above assumptions, but the soluble silica found in the MW-13 sample is higher than that estimated from the cement content. It should also be noted that the cement content itself is an estimation, based on assumptions described in ASTM C-1084.

*****

Respectfully submitted,
LAW & COMPANY

By 

5 32000eh

RFD 2 Box 181JA
Meredith, N.H. 03253
Phone (603) 279-4425
FAX # 603-279-8717

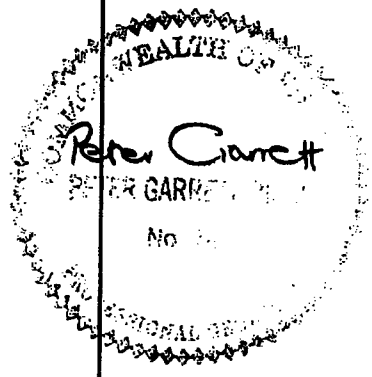
Emery & Garrett Groundwater Inc.

Project: *Loudoun Landfill, VA.*
Driller: *Groundwater Systems, Inc.*
Geologist: *J.A. Brooks, Ph.D.*
DNR Observer: *Nnamdi Madakor*
Well: *MW 17*

Date Drilled: *May 29, 1991*
Depth to Bedrock: *unknown*
Total Depth Drilled: *80'*
Estimated Yield: *< 1 gpm*
Static Water Level: *56.61' t.o.c. (6/18/91)*

Geologic Log of Monitoring Well MW 17

Elevation (MSL)	Depth (Feet)	Description of Lithologies Penetrated	Split Spoon Data: % Recovery	Split Spoon Data: Interval
395.58'	0-	*Dry, dark-red, silty saprolite after conglomerate. Variable colored clay cuttings derived from the alteration of clasts.*	*Cuttings observed but not sampled as per DNR request.*	
	10-			
	20-			
	30-	*Slightly damp red-brown saprolite with fragments of friable red sandstone and chlorite schists and unweathered quartzite.*		
	40-			
	50-	*Lost dust at approximately 49'. Possible water table level.* *Cuttings occurred in smalls moist balls.*		
	60-	*63' - Lost circulation temporarily (due to increased moisture in saprolite?).*		
	70-	*72'- Rod covered with soupy mud. Cuttings covered with watery mud when drilling recommenced.*		
315.58'	80-			



LEGEND

Dry, red to red brown, silty saprolite after conglomerate. Bedding structure is often well preserved. Clasts within conglomerate have been altered to clays of different colors. Shading indicates that saprolite becomes more competent and less weathered with depth.

Conglomerate rock with clasts listed below and a matrix of red to brown sandstone .

Unweathered clasts of quartzite , mafic schist , and sandstone .

RFD 2 Box 1813A
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Phone (603) 279-4425
FAX # 603-279-8717

Emery & Garrett Groundwater Inc.

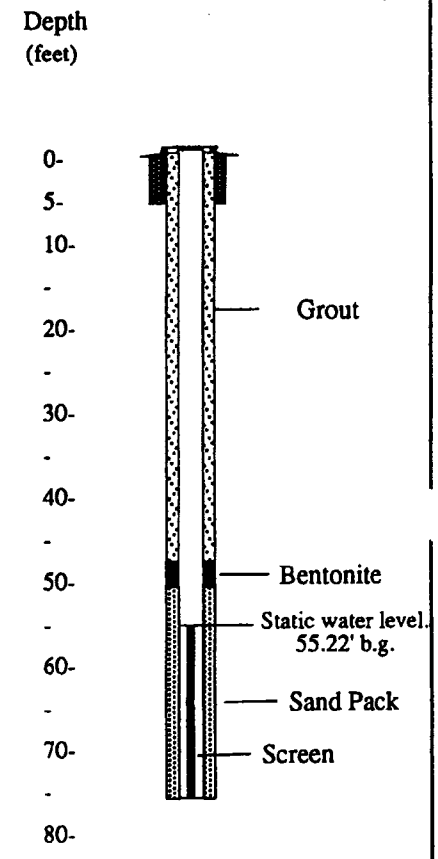
Project: *Loudoun Landfill, VA.*
Driller: *Groundwater Systems*
Geologist: *J.A. Brooks, Ph.D.*
DNR Observer: *Nnamdi Madakor*
Well: *MW 17*

Date Constructed: *May 29, 1991*
Depth to Bedrock: *unknown*
Total Depth of Well (g.l.): *76'*
Static Water Level: *56.61 ' t.o.c. (6/18/91)*

Monitoring Well MW 17 "As Built" for Loudoun County Landfill

Elevation (MSL)	Depth (Feet)	Construction Details
395.58'	-1.39'	12" — 8" square steel protective casing 2' above ground level
		Sand
		Drain holes (2)
	0	Ground Level
		Sloped apron with a 2' radius; Portland cement
	5'	Grout
		4" Schedule 40 PVC riser pipe
	47'	3.5' Bentonite
	50.5'	2' 40 x 200 clean quartz sand
	52.5'	Static water level. 55.22' b.g. (6/18/91)
	55.5'	22' 16 x 40 clean quartz sand
		2 - 10', 4" Schedule 40 PVC Screen (10 slot)
	75.5'	End Cap
319.58'	76'	4" — 8"

Well Construction



COMMONWEALTH OF VIRGINIA
Peter Garrett
PETER GARRETT Ph. D.
No. 741
PROFESSIONAL GEOLOGIST

8.7x Horizontal Exaggeration

Meredith, N.H. 03253
Phone (603) 279-4425
FAX # 603-279-8717

Emery & Garrett Groundwater Inc.

Project: *Loudoun Landfill, VA.*
Driller: *Groundwater Systems, Inc.*
Geologist: *K. C. Hardcastle, Ph.D.*
DNR Observer: *Nnamdi Madakor*
Well: *MW 17A*

Date Drilled: *May 23-28, 1991*
Depth to Bedrock: *90'*
Total Depth Drilled: *250'*
Estimated Yield: *Dry*

Geologic Log of *Abandoned* Monitoring Well MW 17A

Elevation (MSL)	Depth (Feet)	Description of Lithologies Penetrated	Split Spoon Data: % Recovery	Split Spoon Data: Interval
395.07'	0-	*Dry, dark-red, silty saprolite with 15% competent quartzite clasts and 45% clasts altered to orange-brown and light green clays.*		*Cuttings observed but not sampled above 140' per DNR request. Cuttings collected every 10' from 150' down.*
	10-			
	20-			
	30-			
	40-			
	50-	*48'-49' Numerous competent quartzite clasts. Otherwise saprolite after conglomerate as above.*		
	60-	*Saprolite material as above. Cuttings moist at 60' - approx. water table elevation.*		
	70-	*Blowing about 5 gpm. Slower drilling: apparently nearing bedrock. Cuttings of conglomerate.*		
	80-	*Material as above, cuttings include <1% matrix fragments.*		
	90-	*Conglomerate rock from 90' after transition from saprolite. Cuttings include matrix fragments. Blow yield about 10-15 gpm. (gradual increase in yield from 60')*		
	100-			
	110-	*110' gradual increase in yield to about 15-20 gpm.*		
	120-			
	130-	*126'-132' fast and slow drilling through void and/or fracture zone. Temporary loss of circulation. Apparent yield decrease to about 10 gpm, but then possibly picked up additional water below this zone (to 25 gpm). Cuttings of conglomerate.*		
255.07'	140-	*140' Yield unsteady at about 25 gpm because of inability to extract cuttings. Cuttings of conglomerate.*		

Continued

COMMONWEALTH OF VIRGINIA
Peter Garrett
PETER GARRETT, Ph. D.
No. 741
PROFESSIONAL GEOLOGIST

LEGEND

Dry, red to red brown, silty saprolite after conglomerate. Bedding structure is often well preserved. Clasts within conglomerate have been altered to clays of different colors. Shading indicates that saprolite becomes more competent and less weathered with depth.

Conglomerate rock with clasts indicated below and a matrix of red to brown sandstone.

Unweathered clasts of quartzite, mafic schist, and sandstone.

RFD 2 Box 1813A
Meredith, N.H. 03253
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Emery & Garrett Groundwater Inc.

Project: *Loudoun Landfill, VA.*
Driller: *Groundwater Systems, Inc.*
Geologist: *K. C. Hardcastle, Ph.D.*
DNR Observer: *Nnamdi Madakor*
Well: *MW 17A*

Date Drilled: *May 23-28, 1991*
Depth to Bedrock: *90'*
Total Depth Drilled: *250'*
Estimated Yield: *Dry*

Geologic Log of ***Abandoned*** Monitoring Well MW 17A

Elevation (MSL)	Depth (Feet)	Description of Lithologies Penetrated	Split Spoon Data: % Recovery	Split Spoon Data: Interval
		Continuation		
245.07'	150-	*Cuttings of conglomerate.*		*Cuttings sampled every 10'.*
	160-	*After setting casing to 145' the hole is DRY.*		
	170-	*No water bearing zones encountered below 132'.*		
	180-	*This bottom section of the hole produces no water*		
	190-			
	200-			
	210-			
	220-			
	230-			
	240-			
145.07'	250-*	*Terminated hole at 250' per DNR's request.*		

COMMONWEALTH OF VIRGINIA
Peter Garrett
PETER GARRETT, Ph. D.
No. 741
PROFESSIONAL GEOLOGIST

** Because the borehole was completely dry from 145' to 250' the well was abandoned. Therefore, a monitoring well was not constructed at this location.*

LEGEND

Dry, red to red brown, silty saprolite after conglomerate. Bedding structure is often well preserved. Clasts within conglomerate have been altered to clays of different colors. Shading indicates that saprolite becomes more competent and less weathered with depth.

Conglomerate rock with clasts indicated below and a matrix of red to brown sandstone .

Unweathered clasts of quartzite , mafic schist , and sandstone .

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Emery & Garrett Groundwater Inc.

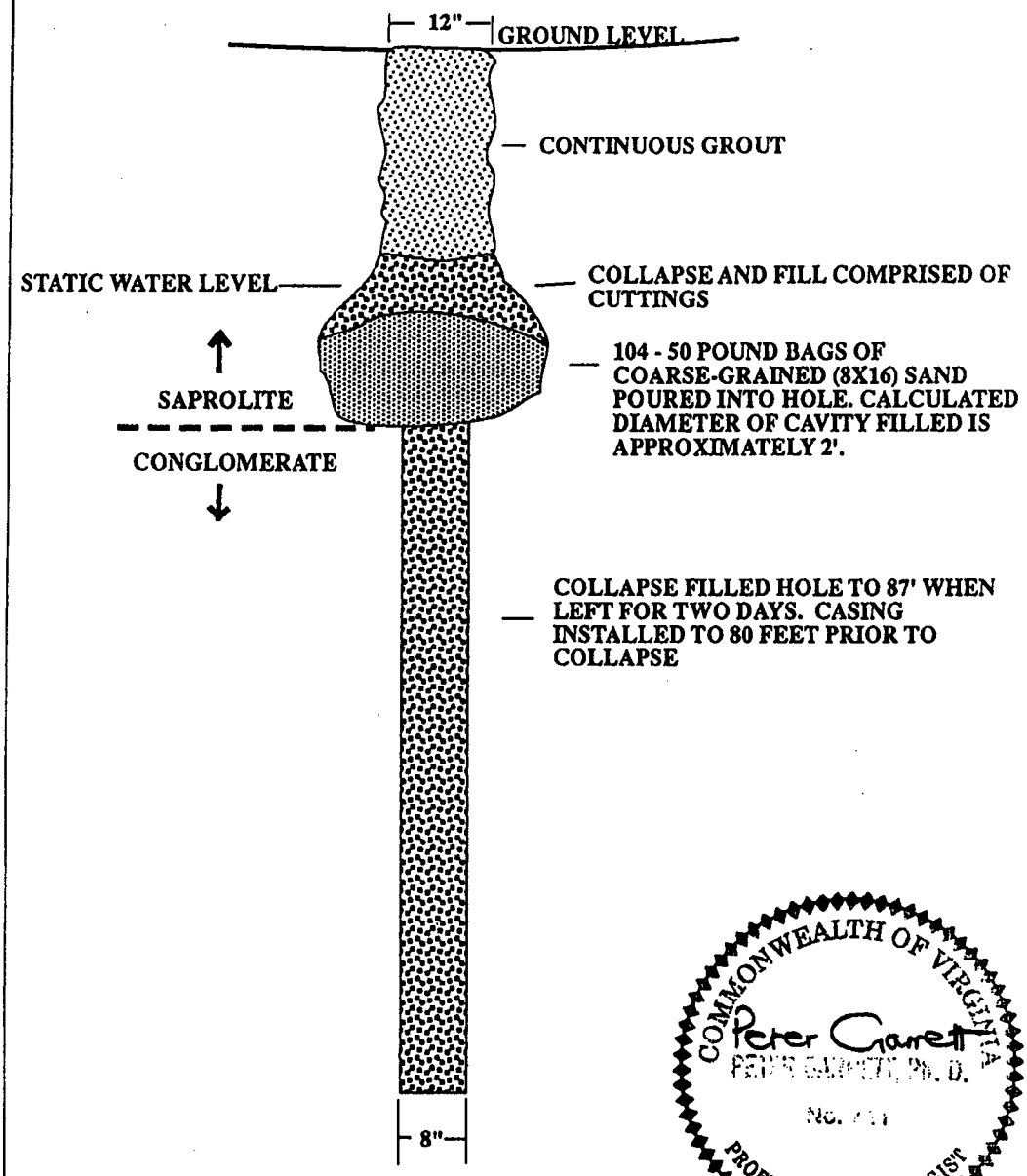
Project: *Loudoun Landfill, VA.*
Driller: *Groundwater Systems*
Geologist: *J.A. Brooks, Ph.D.*
DNR Observer: *Nnamdi Madakor*
Well: *MW 17A*

Date Abandoned: *May 28-31, 1991*
Depth to Bedrock: *90'*
Total Depth (g.l.): *250'*

Abandonment Details for Monitoring Well MW 17A

Elevation (MSL)	Depth (Feet)
395.07'	0-
	10-
	20-
	30-
	40-
	50-
	60-
	70-
	80-
	90-
	100-
	110-
	120-
	130-
	140-
	150-
	160-
	170-
	180-
	190-
	200-
	210-
	220-
	230-
	240-
145.07'	250-

Construction Details



25 x Horizontal Exaggeration

RFD 2 Box 1813A
Meredith, N.H. 03253
Phone (603) 279-4425
FAX # 603-279-8717

Emery & Garrett Groundwater Inc.

Project: *Loudoun Landfill, VA.*
Driller: *Groundwater Systems, Inc.*
Geologist: *K. C. Hardcastle, Ph.D.*
DNR Observer: *Nnamdi Madakor*
Well: *MW 18*

Date Drilled: *May 21, 1991*
Depth to Bedrock: *90'*
Total Depth Drilled: *140'*
Estimated Yield: *approx. 60 gpm*
Static Water Level: *59.71' t.o.c. (6/19/91)*

Geologic Log of Monitoring Well MW 18

Elevation (MSL)	Depth (Feet)	Description of Lithologies Penetrated	Split Spoon Data: % Recovery	Split Spoon Data: Interval
396.45'	0-	*Dry, dark-red, silty saprolite with 15% competent quartzite clasts and 45% clasts altered to orange-brown and light green clays.*		
	10-		50%	10'-12'
	20-		40%	20'-22'
	30-		80%	30'-32'
	40-		40%	40'-42'
	50-	*45' - 56' Numerous competent quartzite and greenstone clasts preclude split spoon sample at 50'. Sampled at next possible depth: 57'-59'.*		
	60-	*No sample recovered at 60' due to resistant clasts. Rod wet when removed from hole. Got sample at 62' - material as above.*	35% 0% 40%	57'-59' 60'-67' 62'-6
	70-	*Yield about 20 gpm. No sample recovered at 70' due to resistant quartzite clasts. Slower drilling: apparently nearing bedrock. Cuttings of conglomerate.*	0%	70'-72'
	80-	*Cuttings recovered from 70' down. Material as above but cuttings include <1% matrix fragments.*	*Sampled cuttings every 10' from 70' down.*	
	90-	*Conglomerate rock from 90' after about 15' transition from saprolite. Cuttings include matrix fragments.*		
	100-	*103'-106' numerous resistant mafic schist clasts.*		
	110-			
	120-	*115-117' fast drilling through void and/or fracture zone. Yield increase to about 60 gpm. Cuttings of conglomerate as above.*		
	130-	*133' Bottom of well as built.*		
256.45'	140-	*140' Yield steady below 117' at about 60 gpm. Cuttings of conglomerate as above.*		

COMMONWEALTH OF VIRGINIA
Peter Garrett
PETER GARRETT P.G.
No. 741
PROFESSIONAL GEOLOGIST

LEGEND

Dry, red to red brown, silty saprolite after conglomerate. Bedding structure is often well preserved. Clasts within conglomerate have been altered to clays of different colors. Shading indicates that saprolite becomes more competent and less weathered with depth.

Conglomerate rock with clasts indicated below and a matrix of red to brown sandstone.

Unweathered clasts of quartzite, mafic schist, and sandstone.

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FAX # 603-279-8717

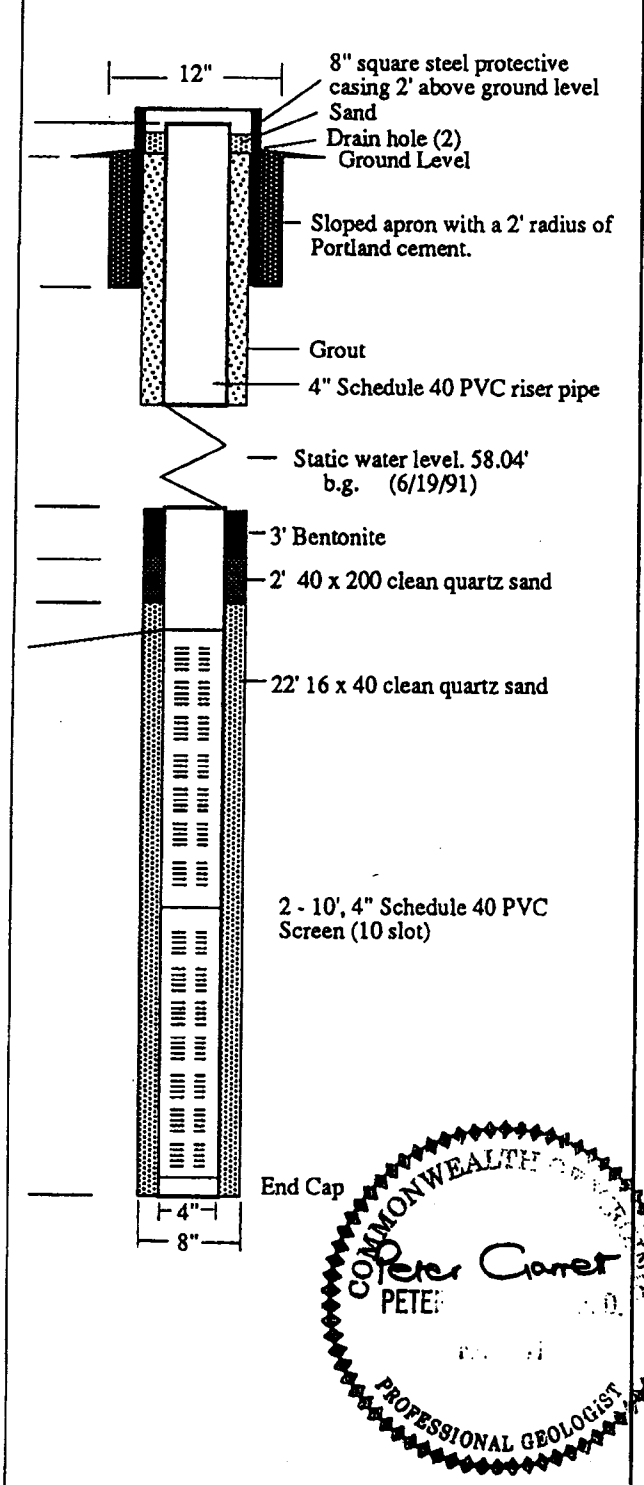
Emery & Garrett Groundwater Inc.

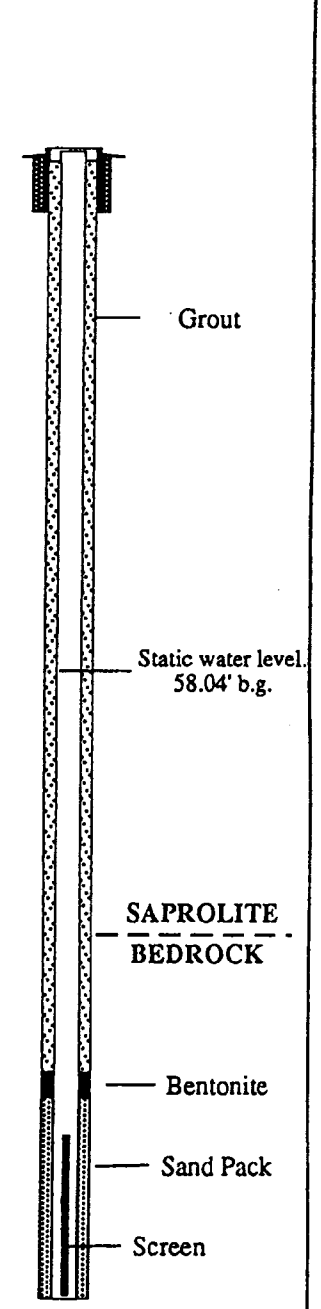
Project: *Loudoun Landfill, VA.*
Driller: *Groundwater Systems*
Geologist: *K.C. Harcastle, Ph.D.*
DNR Observer: *Nnamdi Madakor*
Well: *MW 18*

Date Constructed: *May 22, 1991*
Depth to Bedrock: *90'*
Total Depth of Well (g.l.): *133'*
Static Water Level: *59.71' t.o.c. (6/19/91)*

Monitoring Well MW 18 "As Built" for Loudoun County Landfill

Elevation (MSL)	Depth (Feet)	Construction Details	Well Construction





5.7x Horizontal Exaggeration

RFD 2 Box 1813A
Meredith, N.H. 03253
Phone (603) 279-4425
FAX # 603-279-8717

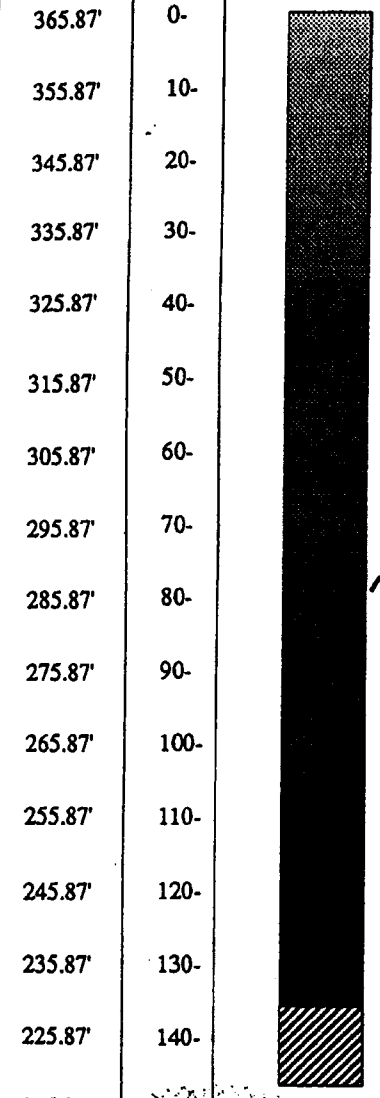
Emery & Garrett Groundwater Inc.

Project: *Loudoun Landfill, VA.*
Driller: *Groundwater Systems*
Geologist: *D.J. Tinkham, MS*
DNR Observer: *Nnamdi Madakor*
Well: *MW 30*

Date Drilled: *March 13-20,1991*
Depth to Bedrock: *138'*
Total Depth: *138'*
Estimated Yield: *> 150 gpm*
Static Water Level: *29' (3/21/91)*

Geologic Log of Monitoring Well MW 30

Elevation (MSL)	Depth (Feet)	Description of Lithologies Penetrated	Split Spoon Data: % Recovery	Split Spoon Data: Interval
365.87'	0-			
355.87'	10-	*Dry, dark-red, clay rich saprolite with 10% 1-2cm, competent quartzite clasts and 5% partially altered, 3 cm biotite schist clasts.*	40%	10'-20'
345.87'	20-	*As above but no quartzite clasts and only one 1cm, biotite schist clast.*	10%	20'-22'
335.87'	30-	*Well developed saprolite with 20% quartzite clasts.*	15%	30'-32'
325.87'	40-	*As above with 70 % clasts.*	80%	40'-42'
315.87'	50-	*As above but with a 1 cm bed of sandy saprolite with an apparent dip of 30-40 degrees.*	70%	50'-52'
305.87'	60-	*As above with some large competent clasts.*	70%	60'-62'
295.87'	70-	*As above with variable clasts.*	70%	70'-72'
285.87'	80-	*Sampled twice because first sample had 0% recovery. Contact between saprolite which is dominantly clasts and saprolite with 70% matrix.*	70%	80'-82'
275.87'	90-	*Harder drilling at 85'. Dense saprolitic sandstone/siltstone with minor thin black layers. No clasts.*	70%	90'-92'
265.87'	100-	*Three attempts to retrieve sample. Saprolite similar to above with clasts up to 2 inches large. Clasts more competent that above.*	70%	100'-102'
255.87'	110-	*50 % of sample is saprolite after conglomerate and 50% is tightly packed sand with minor small clasts.*	30%	110'-112'
245.87'	120-	*Spoon may have hit large stone; no sample.*	0%	120'-122'
235.87'	130-	*Brown to gray, very fine- to fine-grained sand with minor silt to clay. 12" clasts of black quartzite.*	70%	130'-132'
225.87'	140-	*Saprolite/bedrock interface*		
215.87'	150-			



LEGEND

Dry, red to red brown, clayey silty saprolite after conglomerate. Bedding structure is often well preserved. Clasts within conglomerate have been altered to clays of different colors.

Shading indicates that saprolite becomes more competent and less weathered with depth.

Conglomerate rock with quartzite and mafic schist clasts and a matrix of red to brown sandstone .

Peter Garrett

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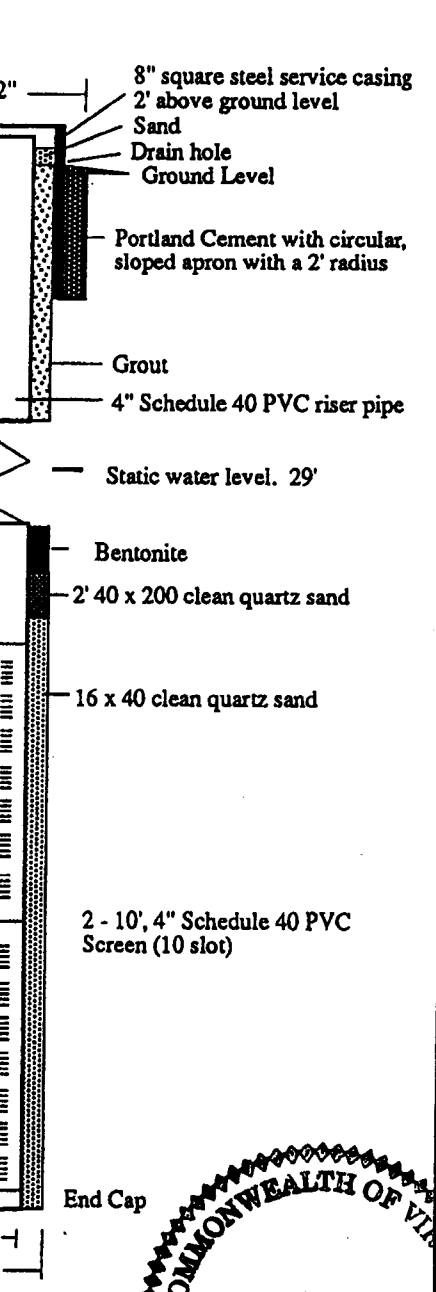
Emery & Garrett Groundwater Inc.

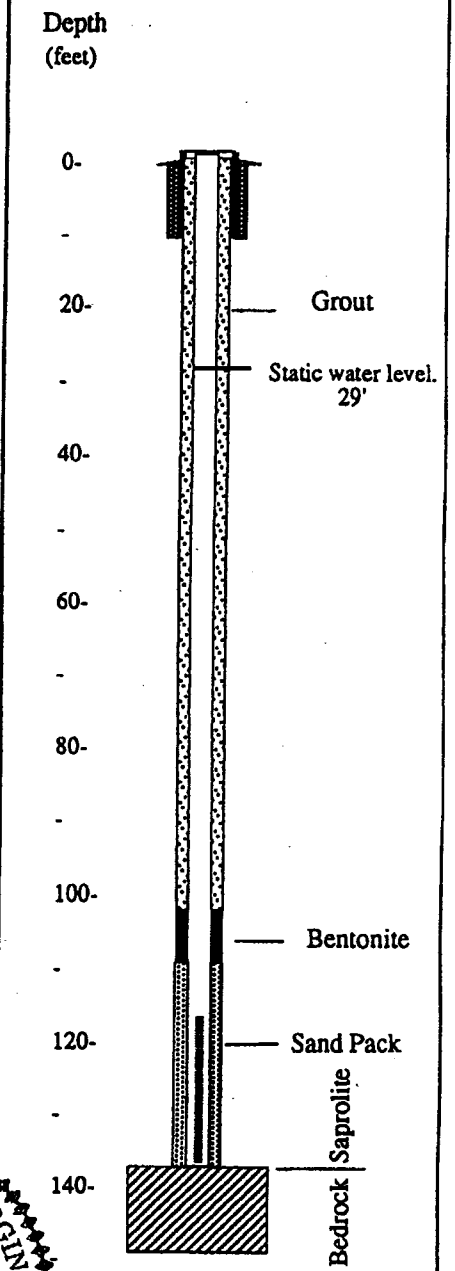
Project: *Loudoun Landfill, VA.*
Driller: *Groundwater Systems*
Geologist: *D.J. Tinkham, MS*
DNR Observer: *Nnamdi Madakor*
Well: *MW 30*

Date Drilled: *March 13-15, 1991*
Depth to Bedrock: *138'*
Total Depth (g.l.): *138'*
Static Water Level: *29' (3/21/91)*

Monitoring Well MW 30 "As Built" for Loudoun County Landfill

Elevation (MSL)	Depth (Feet)
365.87'	0
360.87'	5'
255.54'	110.33'
252.12'	113.75'
250.12'	115.75'
247.87'	118'
226.5'	138'





COMMONWEALTH OF VIRGINIA
PETER GARRETT, Ph. D.
No. 741
PROFESSIONAL GEOLOGIST

Peter Garrett

6.6x Horizontal Exaggeration

Emery & Garrett Groundwater, Inc.
170 Waukewan Street
Meredith, New Hampshire 03253

(603) 279-4425 *Fax (603) 279-8717*

August 25, 1992

Rich Ryan
DEPARTMENT OF NATURAL RESOURCES
COUNTY OF LOUDOUN
750 Miller Drive, S.E.
Suite 200
Leesburg, VA 22075-8919

Dear Rich,

I have enclosed three original copies of the "As Built" and "Geologic" logs for monitoring wells MW-31, MW-33, MW-34, and MW-35 at the Loudoun County Landfill. Also, please find enclosed a copy of my field notes taken during the installation of these four wells.

I apologize for any inconvenience created by the delay in sending these materials to you. Please call if you have any questions.

Sincerely,

Daniel J. Tinkham

Daniel J. Tinkham
Hydrogeologist

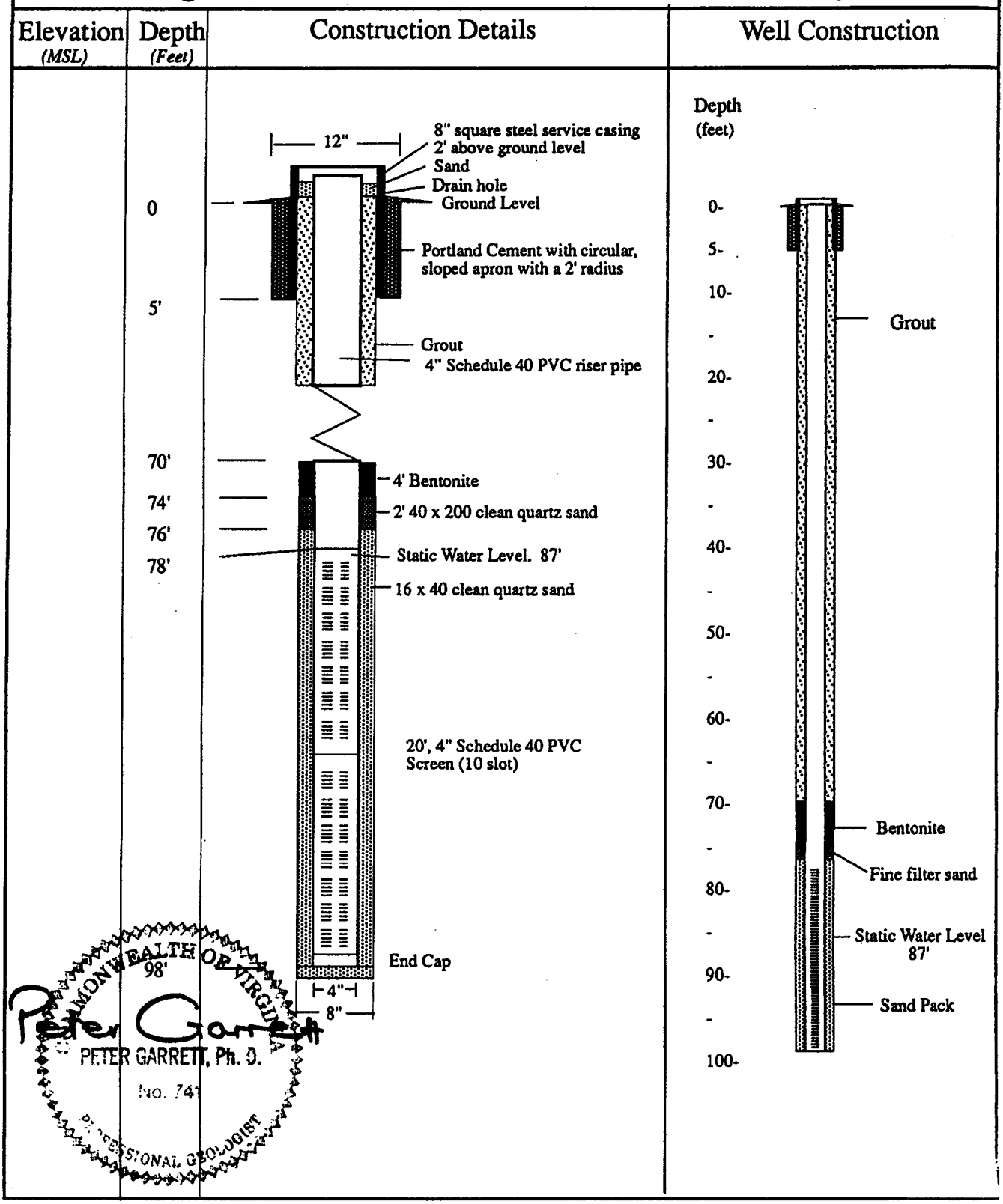
RFD 2 Box 1813A
Meredith, N.H. 03253
Phone (603) 279-4425
FAX # 603-279-8717

Emery & Garrett Groundwater Inc.

Project: *Loudoun County Landfill, VA.*
Driller: *Groundwater Systems*
Geologist: *Daniel J. Tinkham*
DNR Observer: *Richard Ryan*
Well: ***MW-31***

Date Drilled: *March 12-14, 1992*
Depth to Bedrock: *unknown*
Total Depth (b.g.l.): *98'*
Estimated Yield (gpm): *1 gpm*
Static Water Level (t.c): *87' (3/17/92)*

Monitoring Well MW-31 "As Built" for Loudoun County Landfill



COMMONWEALTH OF VIRGINIA
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PROFESSIONAL GEOLOGIST

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Finery & Garrett Groundwater Inc.

Project: *Loudoun County Landfill, VA.*
Driller: *Groundwater Systems, Inc.*
Geologist: *Daniel J. Tinkham*
DNR Observer: *Richard Ryan*
Well: ***MW-31***

Date Drilled: *March 12-14, 1992*
Depth to Bedrock: *unknown*
Total Depth: *98'*
Estimated Yield: *1 gpm*
Static Water Level: *87' (3/17/92)*

Geologic Log of Monitoring Well MW-31

Elevation (MSL)	Depth (Feet)	Description of Lithologies Penetrated	Split Spoon Data: Recovery (in.)	Split Spoon Data: Interval
(Estimate)	0-			
	10-	**10 to 12'** - *Dry, dark-red, clay rich saprolite after matrix supported conglomerate; 50 % highly altered clasts of mafic schists, sandstone, quartzite and 5% unaltered quartz clasts.*	*18"*	*10'-12'*
	20-	**20 to 22'** - *Similar to above, but 60 % matrix.*	*18"*	*20'-22'*
	30-	**30 to 32'** - *4" same as above, with 70% matrix; 14" of red, clayey saprolite after massive f. sandstone and siltstone, no competent quartz grains.*	*18"*	*30'-32'*
	40-	**40 to 42'** - *same conglomerate, with 50 % matrix; competent clasts of quartz and quartzite; sandstone clasts are weathered.*	*8"*	*40'-42'*
	50-	**50 to 52'** - *Dry, same saprolitic conglomerate; 50 % matrix, quartzite is dominant clast type.*	*18"*	*50'-52'*
	60-	**60 to 62'** - *Sample is wet; 9" of same red saprolite after conglomerate, 70 % matrix; and 9" of wet saprolitic conglomerate with a mustard-green matrix.*	*18"*	*60'-62'*
	70-	**70 to 72'** - *Damp, red, saprolitic conglomerate with 70 % matrix; 20% sandstone clasts and 10% quartzite clasts. Chips wet during drilling.*	*8"*	*70'-72'*
	80-	**80 to 82'** - *Damp, same as 70 to 72', some sandstone clasts are more competent; no reaction to HCL.*	*18"*	*80'-82'*
	90-	**90 to 92'** - *Drilling very wet; same conglomerate, 10" of 70%matrix; 8" of 50 % matrix.*	*18"*	*90'-92'*
	100-	**100 to 102'** - *Same wet, red, saprolitic conglomerate; large quartzite clasts, 2-3".*	*4"*	*100'-102'*

COMMONWEALTH OF VIRGINIA
PETER GARRETT, Ph. D.
Peter Garrett
PROFESSIONAL GEOLOGIST

LEGEND

Dry, red to red brown, clayey silty saprolite after conglomerate. Bedding structure is often well preserved. Clasts within conglomerate have been altered to clays of different colors. No remaining calcareous clasts or matrix cement.

Shading indicates that saprolite becomes more competent and less weathered with depth.

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FAX # 603-279-8717

...mery & Garrett Gr...undwater Inc.

Project: *Loudoun County Landfill, VA.*
Driller: *Groundwater Systems, Inc.*
Geologist: *Daniel J. Tinkham*
DNR Observer: *Richard Ryan*
Well: ***MW-33***

Date Drilled: *April 28-29, 1992*
Depth to Bedrock: *102'*
Total Depth: *105'*
Estimated Yield: *10gpm*
Static Water Level: *86.72' (5/1/92)*

Geologic Log of Monitoring Well MW-33

Elevation (MSL) (Estimate)	Depth (Feet)	Description of Lithologies Penetrated	Split Spoon Data: Recovery (in.)	Split Spoon Data: Interval
	0-	**0 to 5'** - *Compacted clayey soil, landfill cover material*		
	10-	**5 to 10'** - *Unsaturated Trash*		
		10 to 22' - *Saturated Trash on top of natural saprolite.*		
	20-			
	30-			
	40-	**40 to 42'** - *Dry, dark-red, clay rich saprolite after clast supported conglomerate; 60 % highly altered clasts of siltstone, 5% quartzite and 5% unaltered quartz clasts; matrix of arkosic sandstone with all grains highly weathered.*	18"	40'-42'
	50-	**50 to 52'** - *Dry, same saprolite; 45% siltstone clasts, 10% quartzite, 5% quartz.*	18"	50'-52'
	60-	**60 to 62'** - *Dry, same saprolite, but brown-red, matrix supported; 20% quartzite clasts, 10% siltstone, most clasts are competent, no reaction to HCL.*	18"	60'-62'
	70-	**70 to 72'** - *8" of Dry, brown saprolitic conglomerate with 90 % matrix; 10% siltstone clasts and trace quartzite clasts. Chips wet during drilling. 6" of dry, saprolite after clast supported conglomerate. Boulder 72-76'.*	14"	70'-72'
	80-	**80 to 82'** - *Dry, same as above; clasts more competent, matrix sandier. 20% quartzite clasts and 20% weathered siltstone clasts. No reaction to HCL.*	16"	80'-82'
	90-	**90 to 92'** - *Wet, same saprolite after conglomerate,but brown to gray mottling.*	18"	90'-92'
	100-	**100 to 102'** - *Same wet, brown, saprolitic conglomerate; 40% siltstone clasts, trace quartz.*	6"	100'-102'
		102 to 105' - *Competent bedrock*		
	110-			

COMMONWEALTH OF VIRGINIA
PETER GARRETT, Ph. D.
741
Peter Garrett

LEGEND

Dry, red to red brown, clayey silty saprolite after conglomerate. Bedding structure is often well preserved. Clasts within conglomerate have been altered to clays of different colors. No remaining calcareous clasts or matrix cement.

Shading indicates that saprolite becomes more competent and less weathered with depth.

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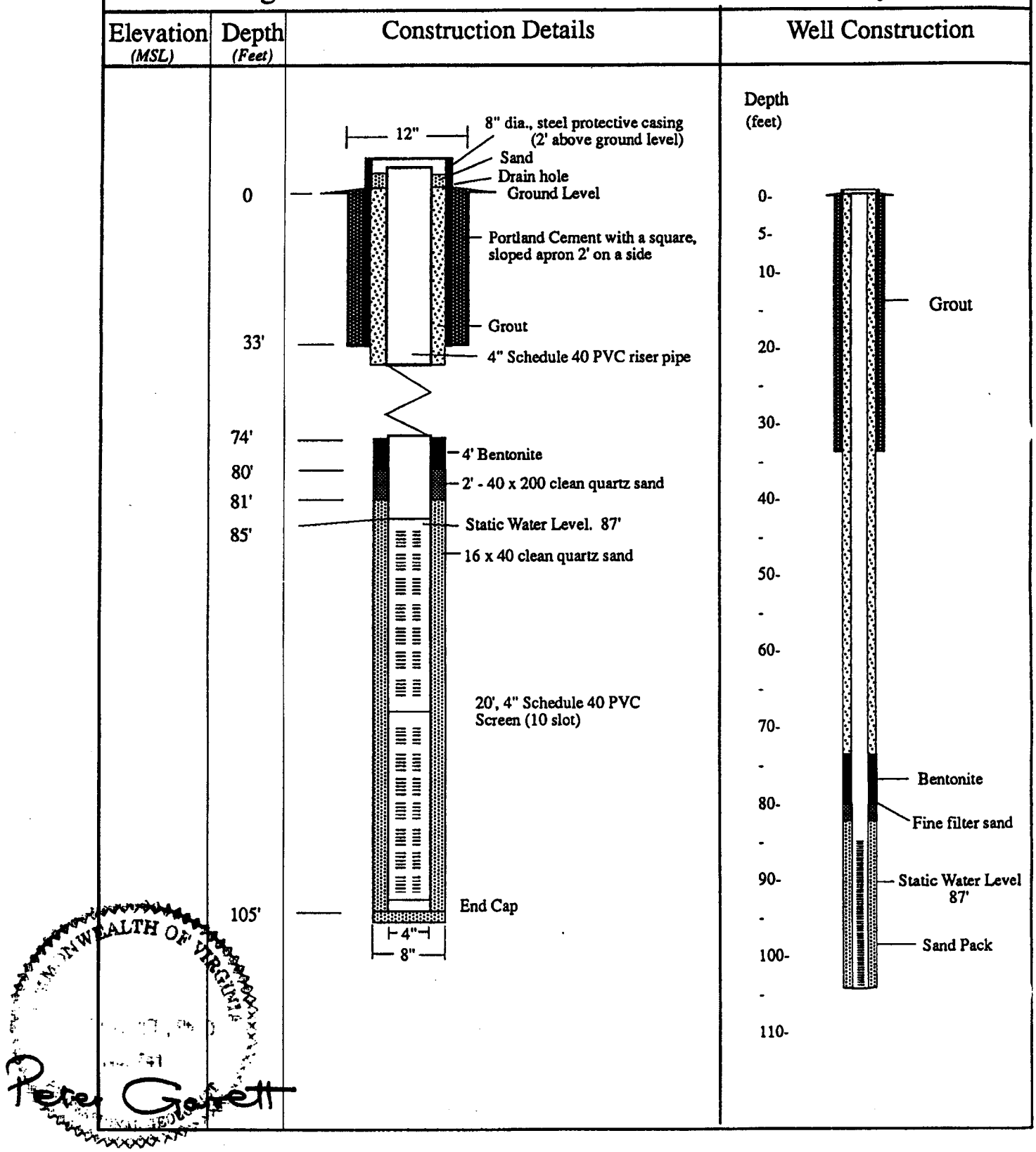
...mery & Garrett Gr...undwater Inc.

Project: *Loudoun County Landfill, VA.*
Driller: *Groundwater Systems*
Geologist: *Daniel J. Tinkham*
DNR Observer: *Richard Ryan*
Well: *MW-33*

Date Drilled: *April 28-29, 1992*
Depth to Bedrock: *102'*
Total Depth (g.l.): *105'*
Estimated Yield (gpm): *10 gpm*
Static Water Level (t.c): *86.72' (5/1/92)*

Monitoring Well MW-33 "As Built" for Loudoun County Landfill



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Peter Garrett

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Emery & Garrett Groundwater Inc.

Project: *Loudoun County Landfill, VA.*
Driller: *Groundwater Systems, Inc.*
Geologist: *Daniel J. Tinkham*
DNR Observer: *Richard Ryan*
Well: ***MW-34***

Date Drilled: *April 29-30, 1992*
Depth to Bedrock: *>100*
Total Depth: *95'*
Estimated Yield: *10 gpm*
Static Water Level: *74.86' (5/1/92)*

Geologic Log of Monitoring Well MW-34

Elevation (MSL) (Estimate)	Depth (Feet)	Description of Lithologies Penetrated	Split Spoon Data: Recovery (in.)	Split Spoon Data: Interval
	0-			
	10-	**10 to 12'** - *Dry, dark-red, clay rich saprolite after clast supported conglomerate; 60% highly altered clasts of sandstone and siltstone, 5% unaltered quartzite. Matrix of arkosic sandstone, no reaction to HCL.*	*18"*	*10'-12'*
	20-	**20 to 22'** - *Dry, similar to above, but 50% matrix, 10% quartzite (up to 2" dia.)*	*18"*	*20'-22'*
	30-	**30 to 32'** - *Dry, 10" same as 20', with 40% clasts and a coarser matrix; 8" of brown, granular, saprolitic pebble conglomerate, with 90% matrix.*	*18"*	*30'-32'*
	40-	**40 to 42'** - *Dry, same saprolite; 50 % matrix, 45% altered siltstone and 5% competent quartz.*	*18"*	*40'-42'*
	50-	**50 to 52'** - *Dry, same saprolite, with 25% weathered siltstone pebbles and 5% quartz; One 3" bed of well-sorted v.f. sand dipping approx. 20 degrees.*	*18"*	*50'-52'*
	60-	**60 to 62'** - *Dry, poor sample; probably drift from saprolite above.*	*6"*	*60'-62'*
	70-	**70 to 72'** - *Dry, same saprolite with 15% competent quartzite and 15% altered siltstone. Chips are granular and moist during drilling between 70 and 80'.*	*3"*	*70'-72'*
	80-	**80 to 82'** - *Wet, brown-red, same saprolitic conglomerate, 35% fairly competent siltstone and 5% quartz. No reaction to HCL.*	*10"*	*80'-82'*
	90-	**90 to 92'** - *Wet fill from above, poor sample, quartzite clast fills tip of spoon. No reaction to HCL in matrix or clasts.*	*4"*	*90'-92'*
	100-			

COMMONWEALTH OF VIRGINIA
Peter Garrett
PETER GARRETT, Ph. D.
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PROFESSIONAL GEOLOGIST

LEGEND

Dry, red to red brown, clayey silty saprolite after conglomerate. Bedding structure is often well preserved. Clasts within conglomerate have been altered to clays of different colors. No remaining calcareous clasts or matrix cement.

Shading indicates that saprolite becomes more competent and less weathered with depth.

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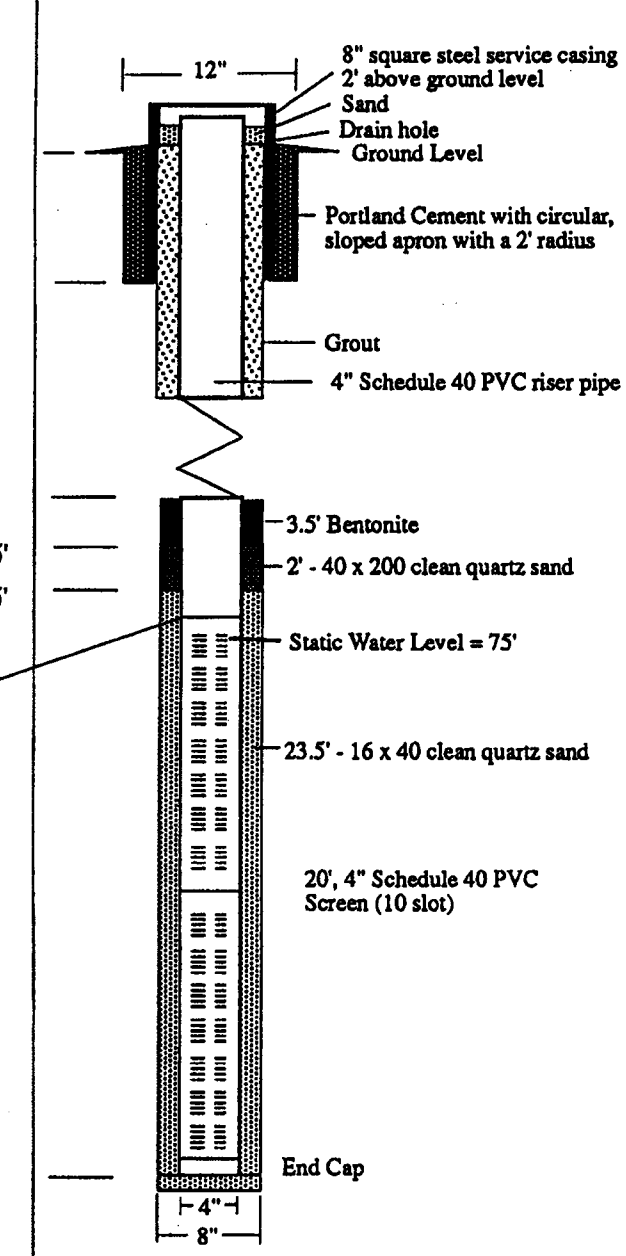
...mery & Garrett Gr...undwater Inc.

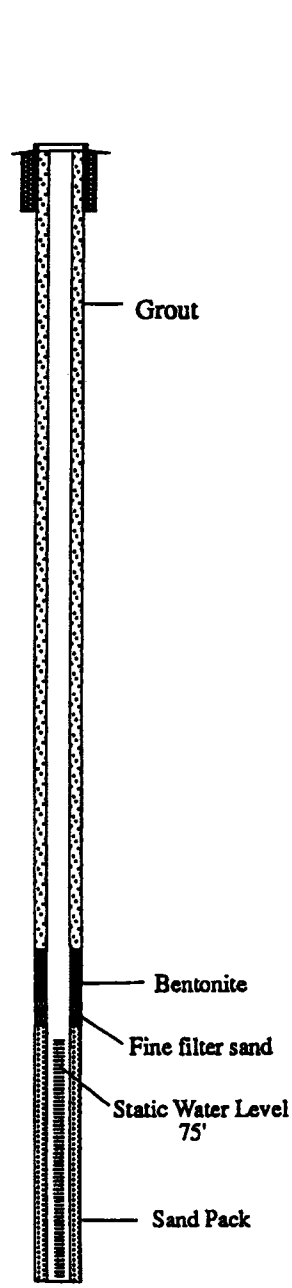
Project: *Loudoun County Landfill, VA.*
Driller: *Groundwater Systems*
Geologist: *Daniel J. Tinkham*
DNR Observer: *Richard Ryan*
Well: ***MW-34***

Date Drilled: *April 29-30, 1992*
Depth to Bedrock: *unknown (>100')*
Total Depth (g.l.): *95'*
Estimated Yield (gpm): *10 gpm*
Static Water Level (t.c): *74.86' (5/1/92)*

Monitoring Well MW-34 "As Built" for Loudoun County Landfill

Elevation (MSL)	Depth (Feet)	Construction Details	Well Construction





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No. 741

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FAX # 603-279-8717

mery & Garrett Gr undwater Inc.

Project: *Loudoun County Landfill, VA.*
Driller: *Groundwater Systems, Inc.*
Geologist: *Daniel J. Tinkham*
DNR Observer: *Richard Ryan*
Well: ***MW-35***

Date Drilled: *April 30, 1992*
Depth to Bedrock: *unknown (>112')*
Total Depth: *84'*
Estimated Yield: *10 gpm*
Static Water Level: *58.38' (5/1/92)*

Geologic Log of Monitoring Well MW-35

Elevation (MSL)	Depth (Feet)	Description of Lithologies Penetrated	Split Spoon Data: Recovery (in.)	Split Spoon Data: Interval
(Estimate)		*Well MW-35 had many more boulders within the conglomerate than at other locations around the landfill. Boulders interfered significantly with the ability to collect split-spoon samples.*		
	0-			
	10-	**10 to 12'** - *Dry, dark-red, clay rich saprolite after matrix supported conglomerate; 35% highly altered clasts of siltstone, 5% quartzite. Matrix of arkosic sandstone, no reaction to HCL.*	*12"*	*10'-12'*
	20-	**20 to 22'** - *Dry, similar to above, with partially preserved bedding, quartzite clasts are weathered.*	*18"*	*20'-22'*
	30-	**30 to 32'** - *Dry, same as 20'.*	*6"*	*30'-32'*
	40-	**40 to 42'** - *Dry, same saprolite as at 20'.*	*6"*	*40'-42'*
	50-	**50 to 52'** - *Dry, same saprolite, with 50% clasts, 40% of those are competent quartzite, some greater than 2" dia.*	*8"*	*50'-52'*
	60-	**60 to 62'** - *Dry, 8" same red saprolite as above, with large quartzite clasts. 10" saprolitic yellow-brown matrix supported conglomerate with 20% gray and yellow siltstone clasts, some more competent than above. Chips moist at 65'.*	*18"*	*60'-62'*
	70-	**70 to 72'** - *Moist, same brown saprolite as the bottom of 60', but fewer gray clasts are competent. No reaction to HCL.*	*12"*	*70'-72'*
	80-	**80 to 82'** - *Wet, poor sample; wet, loose material like at 70'. Sandstone is more competent and no reaction to HCL.*	*2"*	*80'-82'*
	90-	**90 to 92'** - *Wet, yellow-gray saprolitic conglomerate; clasts mostly siltstone. No reaction to HCL.*	*4"*	*90'-92'*

COMMONWEALTH OF VIRGINIA
Peter Garrett
PETER GARRETT, Ph. D.
[illegible]741

LEGEND

Dry, red to red brown, clayey silty saprolite after conglomerate. Bedding structure is often well preserved. Clasts within conglomerate have been altered to clays of different colors. No remaining calcareous clasts or matrix cement.

Shading indicates that saprolite becomes more competent and less weathered with depth.

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▲ mery & Garrett Gr undwater Inc.

Project: *Loudoun County Landfill, VA.*
Driller: *Groundwater Systems*
Geologist: *Daniel J. Tinkham*
DNR Observer: *Richard Ryan*
Well: ***MW-35***

Date Drilled: *April 30, 1992*
Depth to Bedrock: *unknown (>112')*
Total Depth (g.l.): *84'*
Estimated Yield (gpm): *10 gpm*
Static Water Level (t.c): *58.38' (5/1/92)*

Monitoring Well MW-35 "As Built" for Loudoun County Landfill

Elevation (MSL)	Depth (Feet)	Construction Details	Well Construction